Biological Evaluation
For the National Marine Fisheries Service
In regards to the U.S. Virgin Islands
Water Quality Standards

Appendix A:
Critical Habitats for Corals in the US Virgin Islands

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May 2016

Table of Contents

I. Background

The EPA Region 2 initiated informal consultations with the US Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration (NOAA) - The National Marine Fisheries Service (NMFS), referred to as "Services," on the USVI Water Quality Standards Regulations (WQSR) on July 30, 2014. The EPA received a concurrence letter from the FWS on August 6, 2014. On December 29, 2015, the EPA submitted to NOAA-NMFS a draft Biological Evaluation (BE), which has been prepared to support the EPA's determination of "not likely to adversely affect" (NLAA) the threatened and endangered marine species located in the U.S. Virgin Islands waters covered by the subject water quality standards actions. Upon completion of the review of the BE, on April 8, 2016, NOAA-NMFS requested additional information related to the critical habitats designated for corals around the USVI. In addition, the EPA was also asked to provide the list of anticipated water quality standards revisions to be considered during the next triennial WQSR review process scheduled to be completed in 2018. This Appendix is intended to meet both of NOAA's requests.

Many coral stressors are viewed as threats to coral colonies, rather than to the habitat features that provide a conservation function. These stressors (and the corresponding water quality criteria) were previously addressed by the EPA in the BE, as factors contributing to corals protection, rather than to a determination of whether the corals' critical habitat is likely to be destroyed or adversely modified. Thus, the parameters contributing directly to coral protection will not be further addressed in this Appendix. Instead, the factors contributing the evaluation of the coral habitats (e.g., the substrate free from fleshy or turf macroalgal cover would encompass water quality sufficiently free of nutrients) will be discussed in detail. Such stressors have the potential to negatively affect the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment and will be a subject of discussion below, as elements of protection for critical habitats designated for corals.

Based on the key conservation objective, the natural history of elkhorn and staghorn corals, and their habitat needs, the physical or biological feature of elkhorn and staghorn corals' habitat essential to their conservation is substrate of suitable quality and availability to support successful larval settlement and recruitment, and reattachment and recruitment of fragments. For purposes of this definition, ''substrate of suitable quality and availability'' means natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover. This feature is essential to the conservation of these two species due to the extremely limited recruitment currently being observed (73 FR 72210).

II. Federally listed coral species

The ongoing informal consultation with NOAA-NMFS addresses the following Endangered Species Act (ESA) - listed coral species and their designated critical habitats around the USVI:

- Elkhorn coral, *Acropora palmata;* listed in 2006
- Staghorn coral, *Acropora cervicornis;* listed in 2006
- Pillar coral, *Dendrogyra cylindrus;* listed in 2014
- Lobed star coral, *Orbicella annularis;* listed in 2014
- Mountainous star coral, *Orbicella faveolata;* listed in 2014
- Boulder star coral, *Orbicella franksi;* listed in 2014
- Rough cactus coral, *Mycetophyllia ferox;* listed in 2014.

III. Critical Habitats designated for Corals in the USVI

According to the ESA (section 3) and 50 CFR 424.02(d), critical habitat is defined as specific areas within the geographical area occupied by the species at the time of listing (if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection) and specific areas outside the geographical area occupied by the species at the time of listing (if NOAA determines that the area itself is essential for the conservation of the species).

Out of seven ESA-listed corals species of interest under this consultation, to date, NOAA-NMFS designated critical habitat for two species: elkhorn and staghorn corals, which were listed as threatened on May 9, 2006. Elkhorn and staghorn corals were once the most abundant and most important species on Caribbean coral reefs in terms high growth rates that have allowed reef growth to keep pace with sea level changes. In addition, branching morphologies of both species have been providing an important habitat for other reef organisms.

Detailed description of both coral species, along with their status, life history and environmental baseline have been provided in section VI of the BE. Staghorn coral is characterized by yellow to brown antler-like colonies with white growing tips and cylindrical, straight, or slightly curved branches ranging from 1 to 4 cm in diameter. The linear growth rate for staghorn coral has been reported to range from 3 to 11.5 cm/year (73 FR 72210). Elkhorn coral colonies are flattened to near round with frond-like branches. Branches are up to 50 cm across and range in thickness from 2 to 10 cm, tapering towards the branch terminal. Like staghorn coral, elkhorn branches are also brown to tan with white growing tips. The linear growth rate for elkhorn coral is reported to range from 4 to 11 cm/year. Individual colonies can grow to at least 2 m in height and 4 m in diameter.

Critical habitat for both, elkhorn and staghorn, corals was proposed by NOAA-NMFS on February 6, 2008 in the Federal Register (FR) notice (73 FR 6895). For both corals, the proposed rule identified the key conservation objective as facilitating increased incidence of successful reproduction. To support this conservation objective, NOAA-NMFS determined the feature essential to the conservation of the species as “substrate of suitable quality and availability” (hard bottom or dead coral skeleton that is free from fleshy macroalgae cover and sediment cover), in water depths from the mean high water line to 30 m, to support successful larval settlement, recruitment, and reattachment of fragments.

In February 6, 2008 FR notice, NOAA-NMFS proposed to designate four specific areas that contain the essential feature: (1) the Florida area, which comprised approximately 3,301 square miles (8,550 sq km) of marine habitat; the Puerto Rico area, which comprised approximately 1,383 square miles (3,582 sq km) of marine habitat; the St. John/ St. Thomas area, which comprised approximately 121 square miles (313 sq km) of marine habitat; and the St. Croix area, which comprised approximately 126 square miles (326 sq km) of marine habitat.

On November 26, 2008, NOAA-NMFS designated critical habitat for elkhorn and staghorn corals and published it in the FR notice (73 FR 72210). Critical habitat was designated in four specific areas: Florida (1,329 square miles), Puerto Rico (1,383 square miles), and the USVI: St. John/St. Thomas (121 square miles) and St. Croix (126 square miles). As it is indicated in the background section of this FR notice, these areas support the objective for "substrate of suitable quality and availability" to support successful larval settlement, recruitment and reattachment of coral fragments. This Appendix will focus on addressing the critical habitats designated for corals around the USVI only.

A. Locations of the elkhorn and staghorn corals around the USVI

According to the NOAA, in general, elkhorn and staghorn corals have the same distribution and are widely distributed throughout the Caribbean (73 FR 72210). For specific locations of the critical habitats designated for both corals around the USVI islands, please refer to maps located in section VIII of this document.

The USVI supports populations of coral species, particularly at Buck Island Reef National Monument. St. Croix has coral reef and colonized hard bottom surrounding the entire island. As stated in the FR notice, according to NOAA's data from the 1980s, both coral species were present along the north, eastern, and western shores of St. Croix at that time. However, the current GIS data (compiled by NOAA) indicate the presence of elkhorn and staghorn corals (currently) along the north, northeastern, south, and southeastern shores of St. Croix (73 FR 72210). As stated in the FR notice, because the monitoring data may not be complete, it is possible that unrecorded colonies of both coral species are indeed present along the western, northwestern, or southwestern shores.

There are limited GIS data available for elkhorn and staghorn presence around the island of St. Thomas. However, according to Grober-Dunsmore et al. (2006), elkhorn colonies were distributed in many locations around the island of St. John from 2001–2003 and according to GIS data, elkhorn colonies were reported around the north and south coasts of the island of St. John (73 FR 72210; Rogers et al., 2007). Additionally, NOAA's data indicate the presence of coral reefs and coral-colonized hard bottom surrounding each of the USVI islands.

IV. Conservation objective

According to the FR notice, there are several implications of the current low population sizes of elkhorn and staghorn coral species throughout the Caribbean (73 FR 72210). Because corals cannot move around and are dependent upon external fertilization in order to produce larvae, fertilization success declines greatly as adult density declines. In addition, neither elkhorn nor staghorn species effectively self-fertilize, thus gametes must be exposed to a different genotype in order to form viable offspring. As a result, in populations where fragmentation dominates, the effective density of genetically distinct adults will be even lower than colony density. According to NOAA-NMFS, it is very likely that this type of recruitment limitation is occurring in some local elkhorn and staghorn populations around the USVI, given their state of significantly reduced abundance. In addition, when adult abundances of elkhorn and staghorn corals are reduced, the source for fragments (to provide for asexual recruitment) is also compromised. Based on these conditions it is expected that once a threshold level of coral population decline has been reached (i.e., a density where fertilization success becomes negligible) the chances for species recovery are low. This is a primary reason why NOAA-NMFS has determined that based on available information, facilitating increased incidence of successful sexual and asexual reproduction is the key objective to the conservation of both species. To address this key objective from the point of view of the water quality is the overall goal of this document.

V. Physical or Biological Features Essential for Conservation (Primary Constituent Elements)

As described by NOAA-NMFS in the FR notice, within the geographical area occupied, critical habitat consists of specific areas in which the physical or biological features (essential to the conservation of the species) are found and are often referred to as the essential features (73 FR 72210). In the FR notice, the agency has determined and described in details the physical and biological features essential to the above described conservation objective.

NOAA's regulations for designating critical habitat (50 CFR 424.12.b) state that physical and biological features that are essential to the conservation of a given species, and thus, may require special management protection may include, but are not limited to: (1) space for growth, (2) nutritional or physiological requirements; (3) shelter; (4) sites for reproduction and (5) habitats representative of the historic ecological distributions of a species. These regulations state that NOAA-NMFS shall focus on essential features within the specific areas considered for designation.

It is a common understanding among researchers that without successful recruits (both sexual and asexual), the coral species will not increase in abundance, distribution, and genetic diversity. Like most coral species, both elkhorn and staghorn require natural consolidated hard substrate for their larvae to settle and fragments to reattach. The type of substrate available directly influences settlement success and the survival of fragments. The availability of appropriate habitat for successful sexual and asexual reproduction is often limited by algae not only overgrowing the space available for larval settlement, fragment reattachment, and recruitment (macroalgae), but also trapping the sediment, leading to greater amounts of accumulations compared to bare substrate alone (turf algae). In addition, sediment accumulating on suitable substrate lowers sexual and asexual reproductive success by preempting available substrate and smothering coral recruits.

Both, elkhorn and staghorn, corals require relatively clear, well-circulated water, with a narrow, optimal pH and temperature ranges. For detailed description of the impacts of the individual water quality parameters (including toxic pollutants such as pesticides, herbicides, metals) directly on elkhorn and staghorn corals, please refer to section VI of the BE document. The overall focus of this document is to address the key objective for the critical habitat restoration, which is facilitating increased incidence of successful sexual and asexual reproduction of both elkhorn and staghorn species. Based on the available scientific data, in accordance with the information provided by NOAA-NMFS in the FR notice (73 FR 72210), the determination was made to evaluate several water quality parameters which appear to play the most significant role in the process of coral's critical habitat restoration.

According to Hughes and Connell (1999), sexual recruitment of elkhorn and staghorn corals is currently limited in some areas and absent in most locations studied around the USVI. In addition, settlement of larvae as well as attachment of fragments are often unsuccessful, given limited amounts of appropriate habitat due to the shift in benthic community structure from coral-dominated to algae-dominated that has been documented since the 1980s. As described in details by NOAA-NMFS, the recent increase in the dominance of fleshy macroalgae observed in the Caribbean, significantly impacts the recruitment of new corals (73 FR 72210). Fleshy macroalgae are able to colonize dead coral skeleton and other available substrate, preempting space available for coral recruitment. Several studies show that coral recruitment tends to be greater when algal biomass is low. In addition to preempting space for coral larvae settlement, many fleshy macroalgae produce secondary metabolites with generalized toxicity, which also may inhibit settlement of coral larvae.

The shift in benthic community structure from the dominance of stony corals to that of fleshy algae on Caribbean coral reefs is primarily attributed to the reduced grazing (due to overfishing and disease) and increased input of nutrient. Nutrients enrichment, on the other side, further impact coral critical habitats through increased turbidity and reduced clarity of water. In addition, sedimentation along with the water temperature and pH were also identified as parameters potentially affecting the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment. As a result, all of these are being identified as parameters of interest, for purpose of this document.

According to the literature, sexual reproduction in corals appears to be strongly influenced by multiple environmental factors and is highly sensitive to a wide range of natural and anthropogenic stressors that cause sublethal stress, reduce reproduction rates, and impair reproductive success (Harrison and Wallace 1990; Fabricius 2005; Mendes and Woodley 2002a).

Environmental factors known to stress corals and negatively affect sexual reproduction include: thermal stress (e.g., Hunter 1988; Nozawa and Harrison 2002, 2007; Bassim et al. 2002; Randall and Szmant 2009; Mendes and Woodley 2002b),ultraviolet radiation (e.g., Gulko 1995; Ward et al. 2003), coral bleaching (e.g., Harrison and Wallace 1990), lowered salinity (e.g., Humphrey et al. 2008), and increased sedimentation and turbidity (e.g., Gilmour 1999; Fabricius et al. 2003; Humphrey et al. 2008), oil pollutants and dispersants (e.g., Guzmán and Holst 1993) and trace metals (e.g., Heyward 1988; Reichelt-Brushett and Harrison 1999, 2000, 2004, 2005).

Sublethal and toxic levels of pollutants also impair or prevent successful coral reproduction, including increased nutrients (e.g., Tomascik and Sander 1987; Ward and Harrison 1997, 2000; Harrison and Ward 2001; Bassim and Sammarco 2003). Results of the experimental studies, published by Harrison and Ward 2001, have shown that dissolved inorganic nutrients negatively affect coral fertilization rates.

These stress effects are likely to be exacerbated by climate change impacts, including modified thermal environments that may disrupt reproductive cycles in corals and inhibit larval settlement and postsettlement survival.

As coral reproduction appears to have a narrower tolerance to stress than other life functions (Harrison and Wallace 1990), it is essential to maintain ecologically appropriate environmental conditions to enable successful reproduction by corals in future.

Nutrients

Nutrients (e.g., nitrogen, phosphorus) have the potential to negatively affect the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment. Nutrient enrichment is a major factor contributing to the corals-to algae shift in benthic community structure and preemption of available substrate suitable for larval settlement, recruitment, and asexual fragment reattachment. As described in more details in the BE, the major factor contributing to the dominance of fleshy macroalgae as major space-occupiers on many Caribbean coral reefs is nutrient enrichment, coming from both, point sources (readily identifiable inputs where pollutants are discharged to receiving surface waters from a pipe or drain) and non-point sources (inputs that occur over a wide area and are associated with particular land uses). Anthropogenic sources of nutrients include sewage, stormwater and agricultural runoff, river discharge, and groundwater; however, natural oceanographic sources like internal waves and upwelling also distribute nutrients on coral reefs.

Coral reefs have been considered to be generally nutrient-limited systems, meaning that levels of accessible nitrogen and phosphorus limit the rates of macroalgae growth. When nutrient levels are raised in such a system, growth rates of fleshy macroalgae can be expected to increase, and this can yield imbalance and changes in community structure. Excess nutrient loads have been shown to affect coral physiology and the balance between corals and their endosymbiotic zooxanthellae (Szmant 2005). Nutrient-rich water can enhance benthic algae and phytoplankton growth rates in coastal areas, and this may result in overgrowth, out-competition, and algal blooms. Increased levels of nutrients have also been shown to reduce growth rates in staghorn corals and compromise their health.

In the Final Listing Rule, NOAA-NMFS (2014) concluded that both elkhorn and staghorn corals are highly susceptible to nutrient enrichment. Laboratory experiments testing the effects of sedimentation and phosphate on staghorn coral species indicated that degenerative changes to tissue, zooxanthellae, and gonad development were more severe in sediment plus phosphate treatments in comparison to controls and phosphate alone (Hodel and Vargas-Angel, 2007). The reduction of fertilization success of gametes from scleractinian reef corals due to elevated levels of nitrogen and phosphorus were reported by Harrison and Ward (2001). The reduction of up to 64% were observed in the laboratory experiments, where the branching coral *Acropora longicyathus* was exposed to the elevated levels of ammonium/phosphate concentrations, compared to controls. The authors concluded that both, ammonium and phosphate enrichment significantly impairs fertilization success and embryo development in scleractinian reef corals.

The anthropogenic source routes for nutrients may also bring additional sediments into the coral reef environment (Fabricius et al., 2005).

Sediments

According to Tomascik and Sander 1987 and Babcock and Davies 1991, the most severe effect of sedimentation is the inhibition of recruitment. In general, thresholds to recover from sedimentation vary between species, however they are an order of magnitude lower for coral recruits than for adult corals.

As described in detail by Fabricius et al. (2003), November through December is the time of mass spawning of many reef invertebrates including the reef-building hard corals. Within the few days (up to few weeks) after the mass spawning event, coral larvae settle on suitable substratum. They metamorphose to primary polyps, which soon start depositing their calcium carbonate skeleton, and add new polyps by budding. After 4 to 6 weeks, these recruits (consisting of 1 to 6 polyps) measure up to 2mm in diameter and 1mm in height. This early post-settlement time is likely to be the most vulnerable stage in the benthic life phase of a coral. The ability of young coral recruits to survive local exposure to sedimentation significantly impacts the ability of coral reef communities to recover from disturbance events.

Fabricius et al. (2003), tested the short-term effects of sediments on the survival of recruits of hard corals (Cnidaria: Scleractinia). This study demonstrated that sediments can significantly damage recruits of the inshore coral *A. willisae* within less than 2 days of deposition, well within the time frames of natural sediment deposition events. Although the mechanisms of this damage are still unknown, anoxia under the sediment, and toxic metabolites of microbes associated with the sediment aggregates may very likely to contribute to produce further, synergistic, damaging effects on the survival of coral recruits.

Sedimentation has the potential to negatively affect the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment. Sediments enter the reef environment through many processes that are natural or anthropogenic in origin, including erosion of coastline, resuspension of bottom sediments, terrestrial run-off (following clearing of mangroves and deforestation of hillsides), beach re-nourishment, and nearshore dredging and disposal for coastal construction projects and for navigation purposes.

Sediment deposition and accumulation affect the overall amount and quality of suitable substrate available for larval settlement and recruitment, and fragment reattachment and recruitment and both sediment composition and deposition affect the survival of juvenile corals (Fabricius et al., 2005). The rate of sedimentation affects reef distribution, community structure, growth rates, and coral recruitment.

Furthermore, algal turfs can also trap sediments, which then creates the potential for algal turfs and sediments to act in combination to hinder coral settlement (73 FR 72210). As described by NOAA-NMFS in the FR notice, these turf algae sediment mats also can suppress coral growth under high sediment conditions and may gradually kill the marginal tissues of stony corals with which they come into contact.

In addition, the accumulation of sediment can smother living corals, dead coral skeleton, and exposed hard substrate. Sediment accumulation on dead coral skeletons and exposed hard substrate reduces the amount of available substrate suitable for coral larvae settlement and fragment reattachment (Rogers, 1990). Accumulation of sediments is also a major cause of mortality in coral recruits (Fabricius et al., 2005). According to NOAA-NMFS, in some instances, if mortality of coral recruits does not occur under heavy sediment conditions, then settled coral planulae may undergo reverse metamorphosis and not survive (73 FR 72210).

Sedimentation, therefore, impacts the health and survivorship of all life stages (i.e., fecund adults, fragments, larvae, and recruits) of elkhorn and staghorn corals. Based on the key conservation objective we have identified, the natural history of elkhorn and staghorn corals, and their habitat needs, the physical or biological feature of elkhorn and staghorn corals' habitat essential to their conservation is substrate of suitable quality and availability to support successful larval settlement and recruitment, and reattachment and recruitment of fragments. For purposes of this definition, ''substrate of suitable quality and availability'' means natural consolidated hard substrate or dead coral skeleton that is free from fleshy or turf macroalgae cover and sediment cover. This feature is essential to the conservation of these two species due to the extremely limited recruitment currently being observed (73 FR 72210).

Clarity

Indirectly, water clarity also has the potential to negatively affect the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment. Water clarity measures the clearness (transparency) of ambient water, indicating how far sunlight is able to travel through the water column. Water clarity is measured by the secchi depth and is closely related to water turbidity, where increased turbidity correlates with decreased clarity.

Clarity is an important water quality parameter for plants that depend on light interception and absorption for photosynthesis and the animals depending on these plants. Water clarity measurement indicates the depth of the photic zone; the zone of water that is exposed to enough sunlight to support photosynthesis. The depth of the photic zone varies with the turbidity of the water. High water clarity, as much as low water turbidity, is a key factor for the well-being of the marine ecosystems. Reduced water clarity, as much as increased water turbidity, leads to prolonged shading and limits depth distribution of coral reefs and seagrasses. In addition, it leads to reduced coral biodiversity and increased macroalgal cover. The intensity of the light penetrating water column was also found to greatly affect photosynthetic rates of the zooxanthellae, indirectly impacting coral growth and survival.

Turbidity

Similar to water clarity, turbidity has the potential to negatively affect the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment. Turbidity is a measure of the amount of suspended particulate matter in the water column (and to a lesser extent some dissolved organic compounds) and their effect on light attenuation. Both organic (bacteria, phytoplankton, zooplankton and detritus), and inorganic (sediment) particles contribute to suspended particulate matter. Turbidity and light attenuation can vary over small spatial and temporal scales depending on the proximity of sources of sedimentation and/or terrestrial runoff as well as changes in local weather conditions. Sedimentation has been identified by NOAA-NMFS as a key stressor for the recovery of coral’s critical habitats (NOAA, 2014).

pH

The pH has the potential to negatively affect the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment. In general, the impact of ocean acidification resulting from rising atmospheric carbon dioxide (CO_2) represents a serious impediment to the recovery of ESA-listed coral species (NOAA 2014). Climate-related ocean acidification has been identified by NOAA-NMFS as one of the major environmental threats for these stony corals. In the Final Listing Rule

(2014), NOAA-NMFS indicated that ocean acidification will likely impact fertilization, settlement success, and post-settlement growth of elkhorn corals and growth rates of staghorn corals.

Albright et al. (2010) reported that increased CO2 substantially impaired fertilization and settlement success in both coral species. Please refer to the BE document, section VI, for detailed description of this study. Ocean acidification was shown to decrease settlement success by 45 to 69% at CO2 concentrations expected for the middle and the end of this century. Albright et al. considered elkhorn coral to be representative of spawning species in general, and thus reported that the fertilization and recruitment success of many spawning corals will likely be impaired as CO2-driven ocean acidification intensifies over time. According to Medina-Rosas et al. (2013), on the other side, most of the concerns about the effects of ocean acidification on marine organisms are related to decreased calcification rates. Thus, the negative effects of decreased pH on the embryonic development of elkhorn coral were not found and they may not manifest until the newly settled polyps begin to calcify. Renegar and Riegl (2005) performed laboratory experiments to examine the effect of CO2 on growth of staghorn corals, maintained in the laboratory and reported significantly reduced growth under CO2 levels of 700 to 800 µatm, predicted to occur this century, compared to controls.

Temperature

Lastly, the water temperature also has the potential to negatively affect the essential feature for elkhorn and staghorn corals by altering the quality and availability of suitable substrate for larval settlement, recruitment, and fragment reattachment. In the Final Listing Rule, NOAA-NMFS (2014) concluded that both coral species are highly susceptible to ocean warming. Lundgren and Hillis-Starr (2008) reported elkhorn colonies to be sensitive to bleaching. High water temperatures also affect elkhorn coral reproduction, where embryos and larvae exhibited more developmental abnormalities, lower survivorship, and decreased settlement at 30 and 31.5°C compared to those at 28 °C (Randall and Szmant, 2009). In addition, elkhorn larvae also exhibited faster development and faster swimming speed at 30 and 31.5 °C compared to controls at 27 and 28 °C (Baums et al., 2013).

VI. The USVI Water Quality Standards Regulations

A. Water quality parameters already adopted by the USVI to increase the protection of critical habitats for corals

The most recent Water Quality Standards Regulations (WQSR) were adopted by the USVI on August 28, 2015, submitted to the EPA for review on April 13, 2016 and approved by the EPA Region 2 on May 2, 2016. The EPA initiated informal consultation with Services (FWS and NOAA-NMFS) on these provisions on July 30, 2014, under Section 7(a)(2) of the ESA. On August 6, 2014 the FWS submitted a concurrence letter to the EPA stating that it concurs with

EPA's determination that the proposed project is not likely to adversely affect threatened and endangered species, therefore no further consultation was required.

All of the new and revised water quality criteria adopted by the USVI in August of 2015 to protect the aquatic life designated uses, which are applicable to the class of the USVI Inland Waters, were approved by the EPA based on already completed consultation with the FWS. All of the new and revised water quality criteria adopted by the USVI to protect the aquatic life designated uses, which are applicable to class A, B or C of the USVI marine and coastal waters, were approved by the EPA subject to the results of the ongoing consultation with NOAA-NMFS. Upon completion of this consultation, the EPA will notify VIDPNR of the results.

Listed below, please find the brief description of the most significant water quality standards, already adopted by the USVI to increase the protection of ESA-listed coral species and designated critical habitats. For a complete list of the water quality standards adopted by the USVI, as well as their detailed description, please refer to section VI of the BE document.

Designated Uses

Class A Waters – Maintenance and propagation of desirable species of aquatic life (including threatened, endangered species listed pursuant to section 4 of the Federal Endangered Species Act and threatened, endangered and indigenous species listed pursuant Title 12, Chapter 2 of the Virgin Islands Code) and primary contact recreation (swimming, water skiing, etc.). Preservation of the unique characteristics of the waters designated as Outstanding Natural Resource Waters (e.g., Natural Barrier Reef at Buck Island, St. Croix and the Under Water Trail at Trunk Bay, St. John), waters of exceptional recreational, environmental, or ecological significance.

Class B and C Waters: Maintenance and propagation of desirable species of aquatic life (including threatened, endangered species listed pursuant to section 4 of the Federal Endangered Species Act and threatened, endangered and indigenous species listed pursuant Title 12, Chapter 2 of the Virgin Islands Code).

Narrative Biocriteria

The Territory shall preserve, protect, and restore water resources to their most natural condition. The condition of these waterbodies shall be determined from measures of physical, chemical, and biological characteristics of each waterbody class, according to its designated use. As a component of these measures, the Territory may consider the biological integrity of the benthic communities living within waters. These communities shall be assessed by comparison to reference conditions(s) with similar abiotic and biotic environmental settings that represent the optimal or least disturbed condition for that system. Such reference conditions shall be those observed to support the greatest community diversity, and abundance of aquatic life as is expected to be or has been historically found in natural settings essentially undisturbed or minimally disturbed by human impacts, development, or discharges. This condition shall be determined by consistent sampling and reliable measures of selected indicator communities of flora and/or fauna and may be used in conjunction with other measures of water quality. Waters shall be of a sufficient quality to support a resident biological community as defined by metrics based upon reference conditions. These narrative biological criteria shall apply to fresh water, wetlands, estuarine, mangrove, seagrass, coral reef and other marine ecosystems based upon their respective reference conditions and metrics.

In utilizing the following guidelines, the Virgin Islands shall preserve, protect, and restore Territorial Waters, excluding inland waters, to their most natural condition.

- Class A Waters - The quality of these waters cannot be altered except towards natural conditions. No new or increased dischargers shall be permitted. The biological condition shall be similar or equivalent to reference condition established for biological integrity within Class A waters.
- Class B Waters - This class of waters allows minimal changes in structure of the biotic community and minimal changes in ecosystem function. Virtually all native taxa are maintained with some changes in biomass and/or abundance; ecosystem functions are fully maintained within the range of natural variability. The biological condition shall reflect no more than a minimal departure from reference condition for biological integrity.
- Class C Waters - This class of waters allows for evident changes in structure of the biotic community and minimal changes in ecosystem function. Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa (community structure) are allowed but sensitive-ubiquitous taxa remain common and abundant; ecosystem functions are fully maintained through redundant attributes of the system. The biological condition shall reflect no more than a minimal departure from reference condition as observed at the least disturbed reference site(s) within Class C waters.

Thermal Policy

In order to protect the Territorial Waters from thermal pollution, the following criteria shall apply: (5) Mixing zones proposed for areas with coral reef ecosystems will have to meet the required water quality standards for temperature and turbidity.

Mixing Zones

The DPNR-DEP, in determining whether to establish/grant a mixing zone, shall apply the following criteria: There shall be no mixing zones for discharges that would likely jeopardize the continued existence of any threatened or endangered species listed pursuant to section 4 of the Federal Endangered Species Act and threatened, endangered and indigenous species listed pursuant Title 12, Chapter 2 of the Virgin Islands Code, or result in the destruction or adverse modification of such species' critical habitat.

Dissolved Oxygen criteria

Class A and B Waters – Not less than 5.5 mg/l, except when due to natural causes.
Class C Waters – Not less than 5.0 mg/l, except when due to natural causes.

Temperature criteria

For all of class A, B and C marine and coastal waters, in areas where coral reefs are located, water temperature shall not exceed 25-29˚C at any time, nor as a result of waste discharge to be greater than 1.0˚C above natural. Thermal policies shall also apply.

Criteria for pH

The USVI has adopted a pH level that cannot be altered except of natural conditions for Class A waters; pH level of not less than 7.0 or greater than 8.3 for Class B waters and pH level of not less than 6.7 or greater than 8.5 for Class C waters. For Classes B and C, the USVI adopted an additional provision stating that the normal (natural) range of pH must not be extended at any location by more than +/- 0.1 pH unit.

Turbidity criteria

For all of class A, B and C marine and coastal waters, in areas where coral reefs are located, a maximum nephelometric turbidity unit reading of one (1) shall be permissible.

Nutrients criteria

For all of class A, B and C marine and coastal waters, phosphorus as total P shall not exceed 50 µg/l in marine and coastal waters.

Criteria for Toxic Pollutants

The USVI adopted all of the 304(a) water quality criteria recommended by the EPA to protect the aquatic life use. Please refer to Section VIII of the Biological Evaluation document for detailed description of the individual criteria and their effects on corals and their critical habitats.

B. Water quality parameters considered for adoption by the USVI (in 2018) to further increase the protection of critical habitats for corals.

The next triennial VIWQSR revision is scheduled for 2018. The EPA Region 2 works closely with the VIDPNR on this process in order to ensure that the applicable water quality standards being adopted by the USVI are protective of ESA-listed species, including 7 species of corals and their applicable critical habitats. Based on our communications with NOAA-NMFS, several water quality parameters have been identified for reevaluation during the upcoming WQSR review process. Below, please find the description and proposed revisions to the parameters of interest. The specific changes being proposed to the language are italicized for easy identification.

Criteria for pH

A new pH standard is being proposed for the areas where coral reefs are located. The proposed pH range in based on NOAA's recommendations. The revised pH standard applicable to class A, B and C waters will read as follows:

(1) Normal range of pH must not be extended at any location by more that ±0.1 pH unit. At no time shall the pH be less than 7.0 or greater than 8.3.

(2) Areas where coral reef ecosystems are located, at no time shall the pH be less than 8.2 or greater than 8.4. (According to the various literature sources, the global ocean pH is reported to be 8.1. The agency will seek NOAA's assistance with the final recommended range of pH to be adopted).

Criteria for Clarity

A new standard for clarity is being proposed for the areas where coral reefs are located. The proposed criterion is based on work performed in the State of Florida and NOAA's recommendations. The VIDPNR will revisit this criterion, as more local data is available and revise it, if necessary. The revised clarity standard applicable to class A, B and C waters will read as follows:

(1) A Secchi disc shall be visible at a minimum depth of one (1) meter. For waters where the depth does not exceed one (1) meter, the bottom must be visible.

(2) In areas where coral reef ecosystems are located, a secchi disc shall be visible at a minimum depth of fifteen (15) meters. For such waters where the depth does not exceed fifteen (15) meters, the bottom must be visible.

Criteria for Nutrients

The USVI adopted Total Phosphorus criterion of 50 ug/L for all USVI marine waters. This criterion is presently being reevaluated by the VIDPNR to ensure that it is protective of corals and their critical habitats. More protective criterion will be adopted, if necessary.
Presently, the USVI is working closely with the EPA Region 2 and EPA HQ to derive a numeric criterion for the total nitrogen, to be applicable for all of the USVI marine waters. As soon as new criteria are derived, EPA will share the draft criteria with NOAA. It is expected that this

criterion will be adopted in 2018. Presently, the USVI does not have the numeric criterion for total nitrogen in their WQSR.

Criteria for Toxic Pollutants

The applicable numeric water quality criteria for the toxic pollutants to protect the aquatic life designated uses will be revised accordingly to the most recent EPA national recommended CWA section 304(a) water quality criteria, published by the Agency prior to the initiation of the public review process.

Criterion for Sediments

The criterion for turbidity will be revised to address the impacts of sediments. Proposed criterion will read as follows: "Turbidity - substances producing objectionable turbidity, *such as sediment*, floating debris, scum and other floating materials attributable to discharges in amounts sufficient to be unsightly, deleterious, or create a nuisance to the enjoyment to the existing or designated uses of the waterbody." The USVI plans to derive and adopt the numeric criterion for sediments in the future.

Downstream protection

In addition, a new narrative criterion will be added to address the downstream protection. Proposed criterion will read as follows: "*Downstream Protection - free of substances that would prevent a level of water quality that provides for the attainment and maintenance of the water quality standards of downstream waters*."

Field studies focusing on the evaluation of the effects of terrestrial runoff from all oceans have provided evidence of long-term changes in coastal and inshore reefs in response to excees sedimentation, turbidity and nutrients (Harrison and Wallace 1990). Studies suggest that enhanced sedimentation or euthrophication alter the composition of coral communities and slow down the recovery of hard coral communities after disturbance events, by significantly affecting larval production (Tomascik and Sander 1987) and coral recruitment (Smith et al., 1981). Protection of downstream effects is especially important for nutrients due to the fact that nitrogen and phosphorus-driven eutrophication of freshwaters and the exposure to pesticides are expected to increase 2.4 to 2.7 –fold by 2050 (Tilman et al. 2001).

Mixing Zones

The Mixing Zones section of the VI WQSR will be revised to further increase the protection of corals and their designated critical habitats. Proposed revisions will read as follows:

(10) The location, design, and operation of the discharge shall minimize impacts on aquatic life, and shall not interfere with biological communities, including *coral reefs*, spawning areas, nursery areas, and fish migration routes to a degree that is damaging to the ecosystem;
(*11) Mixing zones designated for areas with coral reef ecosystems will have to meet the required water quality standards for temperature, pH, clarity and turbidity.*

Biocriteria

The EPA Region 2 is working closely with the Office of Research and Development (ORD) to develop the assessment methodology for coral health in the Puerto Rico and the US Virgin Islands. The Biological Condition Gradient (BCG) is being presently developed for the assessment of coral health. NOAA-NMFS, along with other agencies, is actively involved in this process as well. Based on the Coral BCG, the assessment methodology will be developed to assist the USVI with the implementation of the narrative biocriteria adopted into the VI WQSR in 2010. Although it is our expectation that this process will be finalized within next few years, this biocriteria implementation effort will not be included in the Regulations and will be "adopted" by the USVI outside of the triennial WQSR review process.

VII. Summary

Based on the research described in the BE document submitted to NOAA-NMFS in December of 2015 and corresponding Appendix document, the EPA Region 2 determined that all of discussed numeric and narrative water quality criteria, adopted to date by the USVI, offer protection for all of the ESA-listed species including staghorn and elkhorn coral and their designated critical habitats. Following up on EPA's determination justified in the BE document, the EPA Region 2 finds the water quality standards adopted by the USVI to date, to be beneficial to the protection of all ESA-listed species as well as the critical habitats designated for two coral species and not likely to adversely affect (NLAA) listed species or their critical habitats. As stated in Section VI (B) of this document, both parameters of concern identified in the BE, water pH and clarity, are presently being reevaluated by the USVI. As it was described in detail in the BE and earlier in this Appendix, the EPA Region 2 continues to work closely with the VIDPNR and NOAA-NMFS to reevaluate existing narrative and numeric water quality criteria and to address new issues as more information and data becomes available.

The EPA Region 2 looks forward to the completion of the ongoing informal consultation process on the VI WQSR and to continue working with the VIDPNR and NOAA-NMFS on future revisions to the VI WQSR, as necessary, to further increase protection of all ESA-listed species including corals and their critical habitats.

VIII. References

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IX. Figures

Figure 1: Critical Habitat for Elkhorn and Staghorn Corals – St. Croix

Figure adopted from 73 FR 72210

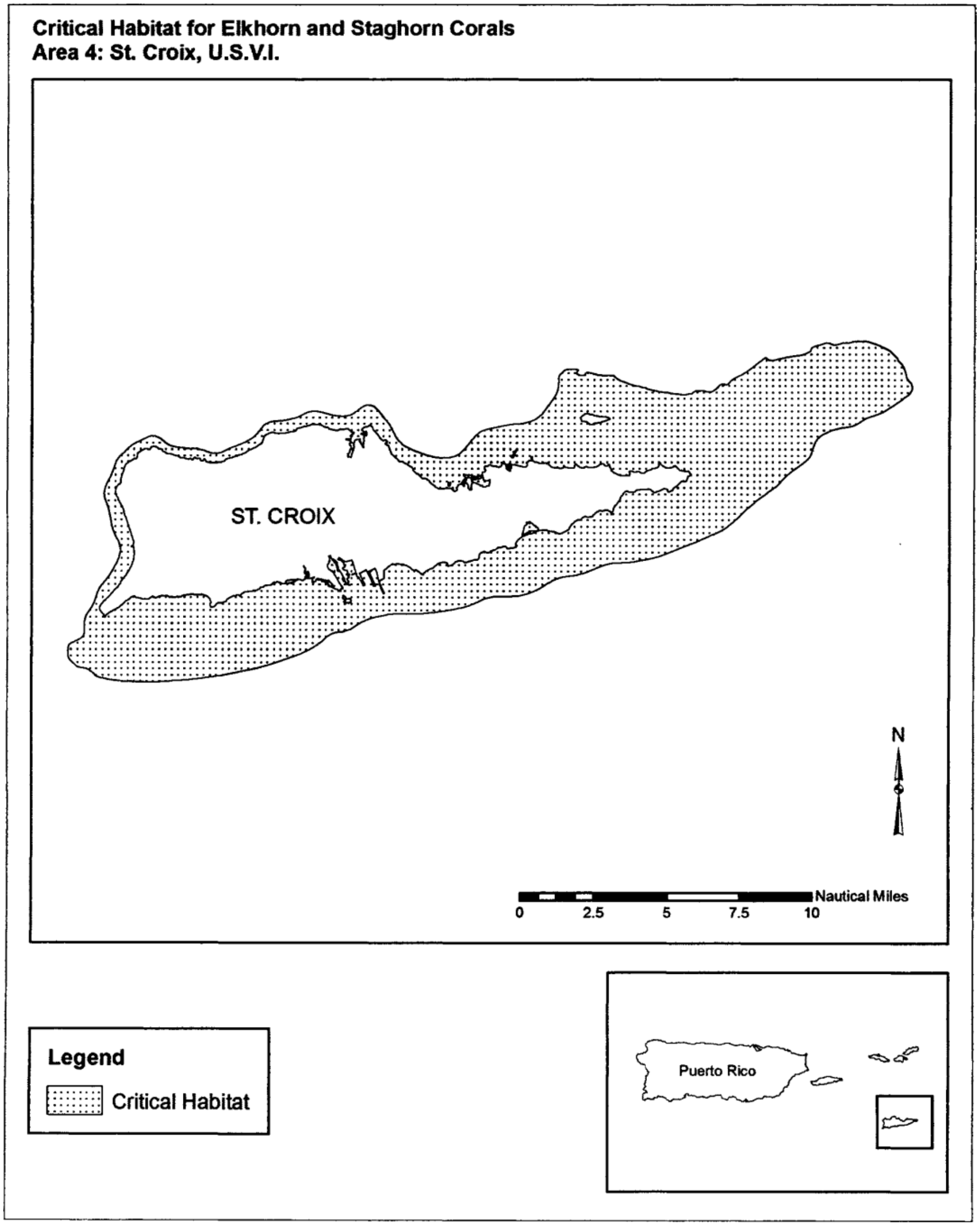

Figure 2: Critical Habitat for Elkhorn and Staghorn Corals – St. Thomas and St. John

Figure adopted from 73 FR 72210